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Age-Related Variations in Body Height, Weight and Body Circumferences among Preadolescent Boys: A Cross Sectional Study

Manoj Kumar Goyal and Ashok Kumar

Abstract

Aim: The present study aimed to assess age-related differences in body height, weight, and body circumferences among preadolescent boys and to observe the significance of these differences across age groups. **Materials and Methods:** A cross-sectional study was conducted on 1040 preadolescent boys aged 6 to 12 years. Body height, weight, and seven anthropometric circumferential measurements were recorded - chest, upper arm, forearm, thigh, calf, waist, and hip. Descriptive statistics including mean and standard deviation were computed for each age group. One-way analysis of variance (ANOVA) was performed to determine overall age differences, followed by Scheffe post hoc tests for pairwise comparisons. **Results**: All variables increased significantly with age ($p < .001$) from 6 to 12 years. Mean height increased from 112.24 ± 6.2 cm at 6 years to 143.59 ± 7.3 cm at 12 years, and mean weight from 19.10 ± 1.6 kg to 42.79 ± 6.0 kg. ANOVA revealed significant differences for height [$F(6, 1033) = 457.33$], weight [$F(6, 1033) = 564.45$], The mean chest circumference increased from 57.00 ± 0.08 cm at age 6 to 70.66 ± 1.26 cm at age 12. Waist circumference demonstrated the largest absolute increase from 51.60 ± 0.09 cm to 65.54 ± 1.54 cm. ANOVA revealed statistically significant differences across age groups for all variables - chest $F(6, 1033) = 1789.03$, $p < .001$; waist $F(6, 1033) = 1620.10$, $p < .001$; hip $F(6, 1033) = 1148.03$, $p < .001$, among others. Scheffe post hoc analysis indicated that most pairwise age comparisons were significant ($p < .05$). However, non-significant differences were observed between 11 and 12 year for upper arm, calf, and hip circumferences, suggesting a plateau in growth in late preadolescence. **Conclusion**: The findings indicate that body height, weight, and body circumferences increase significantly with age from 6 to 12 years during preadolescence, with trunk circumferences showing greater growth compared to limb circumferences.

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Introduction

Physical growth during childhood is a dynamic process characterized by changes in body size, shape, and composition (WHO 1995; Tanner 1990). Anthropometric measurements are fundamental indicators of growth, nutritional status, and body composition during childhood and adolescence. Among these, body height, body weight, body circumferences such as chest, waist, hip, and limb circumferences provide valuable information about skeletal growth, muscle development, and fat distribution patterns. Monitoring these parameters across different age groups helps in understanding normal growth trajectories and in early identification of growth faltering or obesity-related risks (de Onis et al., 2007; WHO 2006 ; Lohman et al., 1988). Preadolescence, approximately between 6 and 12 years of age, is a critical period of growth characterized by steady increases in height, weight, and body dimensions prior to the adolescent growth spurt. During this phase, both genetic and environmental factors influence changes in body proportions. Previous studies have reported that trunk circumferences tend to increase more rapidly than limb circumferences due to differential patterns of fat and muscle deposition. However, reference data on age-wise body circumferences in Indian preadolescent boys remain limited, especially with statistical validation of age differences (Malina et al., 2004; Tanner 1962).Several researchers have emphasized the importance of establishing population-specific anthropometric norms for health screening and clinical assessment. Manoj and Ashok (20226) reported body height, weight, and bony diameters increase significantly from 6 to 12 years in preadolescent boys, but growth continuity differs by site. Appendicular breadths, particularly wrist diameter, provide the most consistent age-related increments and may serve as reliable markers of skeletal maturation. The observed plateaus in axial breadths and stature highlight the non-linear nature of pre-adolescent growth. These findings support the use of multiple anthropometric dimensions for comprehensive growth assessment. Gupta et al. (2009) reported significant age-related increases in chest and waist circumferences among school children, while Singh and Sharma (2011) observed that variability in body circumferences increases with age, reflecting greater heterogeneity in body composition during preadolescence. Despite this, few studies have applied inferential statistics such as ANOVA with post hoc analysis to confirm whether differences between each age year are statistically significant (Singh and Sharma 2011; Gupta et al. 2009; Khongsdier 2002). Given this background, the present study was conducted on body circumferences in preadolescent boys and to statistically evaluate age-related differences. The objectives of the study were to determine the mean and standard deviation of chest, upper arm, forearm, thigh, calf, waist, and hip circumferences in boys aged 6-12 years. To examine whether significant differences exist in body circumferences across different age groups using ANOVA. To identify specific age groups that differ significantly using Scheffe post hoc analysis.

Materials and Methods

Study Design and Sample - A cross-sectional study was conducted on 1040 preadolescent boys aged 6 to 12 years. Participants were recruited from various private schools situated in Nabha (District Patiala) Punjab, India. The sample was divided into seven age groups, with each age group representing boys who had completed the respective year of age. Boys with any known chronic illness, physical deformity, or endocrine disorder that could affect growth were excluded from the study. Informed consent was obtained from parents/guardians and assent from the participants prior to data collection. Ethical approval was obtained from the Institutional Ethics Committee.

Anthropometric Measurements - All anthropometric measurements were taken by using standard techniques as described in the Anthropometric Standardization Reference Manual. Measurements were recorded to the nearest 0.1 cm (Lohman et al., 1988). The following body circumferences were measured:

Chest circumference: Measured at the level of the nipple line during normal expiration.

Waist circumference: Measured at the midpoint between the lower border of the last palpable rib and the top of the iliac crest.

Hip circumference: Measured at the level of maximum extension of the buttocks.

Upper arm circumference: Measured at the midpoint between the acromion process and olecranon process of the right arm.
Forearm circumference: Measured at the maximum girth of the right forearm.
Thigh circumference: Measured at the midpoint between the inguinal crease and the proximal border of the patella.
Calf circumference: Measured at the maximum girth of the right calf.
A non-stretchable measuring tape was used for all circumference measurements. Each measurement was taken twice and the average was recorded.
Statistical Analysis - Data were entered and analyzed using SPSS Version 26.0 (free trial version). Descriptive statistics were computed to obtain mean and standard deviation of all circumferential variables for each age group. To assess differences in body circumferences across age groups, a one-way Analysis of Variance (ANOVA) was performed with age as the independent variable and each body circumference as the dependent variable. The level of significance was set at $p < .05$. Following a significant ANOVA result, Scheffe post hoc test was conducted to determine specific pairwise differences between age groups. Scheffe test was chosen due to its robustness to unequal group sizes and for controlling Type I error across multiple comparisons (Field 2018).

Results

The Table 1 shows descriptive statistics for body height (cm) and body weight (kg) of 1040 pre-adolescent boys, categorized into seven age groups from 6 to 12 years. Age-wise sample size (N) ranged from 104 boys at age 8 to 183 boys at age 12, with a total sample of 1040 participants.
Body height: Mean height showed a progressive increase with age, from 112.24 ± 6.2 cm at 6 years to 143.59 ± 7.3 cm at 12 years. The overall mean height for 6–12-year-old boys was 131.19 ± 12.5 cm. Minimal increase observed between 11 years (143.57 cm) and 12 years (143.59 cm).
Body weight: Mean weight also increased steadily with age, from 19.10 ± 1.6 kg at 6 years to 42.79 ± 6.0 kg at 12 years. The overall mean weight was 29.81 ± 9.1 kg. The largest yearly gain occurred between 10 years (28.40 kg) and 11 years (36.74 kg).
Variability: Standard deviation for both variables generally increased with age, indicating greater inter-individual variation in older age groups, especially for body weight.

Table 1. Mean± SD of Body Height and Weight of Preadolescent Boys

Variable(s)	Age (years)	N	Mean	Std. Deviation
Body height (cm)	6	107	112.24	6.2
	7	148	121.11	4.4
	8	104	122.72	7.0
	9	173	127.93	6.9
	10	153	134.88	7.4
	11	172	143.57	5.9
	12	183	143.59	7.3
	Total	1040	131.19	12.5
Body weight (kg)	6	107	19.10	1.6
	7	148	21.31	3.2
	8	104	24.67	3.2
	9	173	27.39	4.1
	10	153	28.40	4.1
	11	172	36.74	5.3
	12	183	42.79	6.0
	Total	1040	29.81	9.1

The Table 2 shows the results of one-way ANOVA conducted to test differences in mean body height and body weight across the seven age groups (6 to 12 years).

Body height (cm): Between Groups df = 6, Within Groups df = 1033, Mean Square Between Groups = 19885.44, Mean Square Within Groups = 43.48, F(6, 1033) = 457.33, p = .000. This indicates highly significant differences in mean body height across age groups. The very large F-value shows that variation between age groups is much greater than variation within age groups (Table 2).

Body weight (kg): Between Groups df = 6, Within Groups df = 1033, Mean Square Between Groups = 11026.70, Mean Square Within Groups = 19.53, F(6, 1033) = 564.45, p = .000. This also shows highly significant differences in mean body weight across age groups. The F-value for weight is even larger than for height, suggesting stronger age-group differentiation in weight (Table 2).

One-way ANOVA revealed statistically significant differences among age groups for both body height [F(6, 1033) = 457.33, p < .001] and body weight [F(6, 1033) = 564.45, p < .001]. The significant F-values indicate that mean height and weight varied considerably with increasing age from 6 to 12 years.

Table 2. Analysis of Variance (ANOVA) of Body Height and Weight of Preadolescent Boys

Variable(s)		df	Mean Square	F	Sig.
Body height (cm)	Between Groups	6	19885.44	457.33	.000
	Within Groups	1033	43.48		
Body weight (kg)	Between Groups	6	11026.70	564.45	.000
	Within Groups	1033	19.53		

Since One-way ANOVA was significant for both body height and body weight, Scheffe's post-hoc multiple comparison test was applied to identify specific age groups that differed significantly in body height and weight.

The Table 3 shows the results of Posthoc (Scheffe) multiple comparisons of body height and weight.

Body Height (cm): All age groups differed significantly from each other (p < .001), except for two pairs:7 vs 8 years: Mean difference = -1.607 cm, p = .727, not significant and 11 vs 12 years: Mean difference = -0.020 cm, p = 1.000, not significant. Height increased significantly with each year of age from 6 to 11 years. The gain plateaued between 11 and 12 years, where the difference was negligible at 0.02 cm. The largest single-year increment was between 10 and 11 years (-8.687 cm, p < .001) (Table 3).

Body Weight (kg): All age groups differed significantly from each other (p < .05), except:9 vs 10 years: Mean difference = -1.011 kg, p = .643, not significant Weight showed continuous significant increases across ages, with the greatest yearly gains occurring between 10–11 years: -8.343 kg and 11–12 years: -6.050 kg, both p < .001.Unlike height, weight continued to increase significantly even from 11 to 12 years (Table 3).

Scheffe's post-hoc analysis revealed that mean body height increased significantly with age from 6 to 11 years (p < .001 for all consecutive comparisons), but no significant difference was observed between 11 and 12 years (p = 1.000). Similarly, mean body weight increased significantly across age groups (p < .05), except between 9 and 10 years (p = .643). The most substantial annual increments in height and weight occurred between 10 and 11 years of age.

Table 3. Posthoc (Scheffe) Multiple Comparisons of Body Height and Weight of Preadolescent Boys

Dependent Variable	(I) age	(J) age	Mean Difference (I-J)	Sig.
Body height (cm)	6	7	-8.871*	.000
		8	-10.478*	.000
		9	-15.693*	.000
		10	-22.639*	.000
		11	-31.326*	.000
		12	-31.347*	.000
	7	8	-1.607	.727
		9	-6.822*	.000
		10	-13.768*	.000
		11	-22.455*	.000
		12	-22.476*	.000
	8	9	-5.215*	.000
		10	-12.161*	.000
		11	-20.848*	.000
		12	-20.869*	.000
	9	10	-6.945*	.000
		11	-15.633*	.000
		12	-15.653*	.000
	10	11	-8.687*	.000
		12	-8.707*	.000
	11	12	-.020	1.000
Body weight (kg)	6	7	-2.215*	.017
		8	-5.568*	.000
		9	-8.292*	.000
		10	-9.303*	.000
		11	-17.647*	.000
		12	-23.697*	.000
	7	8	-3.352*	.000
		9	-6.076*	.000
		10	-7.087*	.000
		11	-15.431*	.000
		12	-21.481*	.000
	8	9	-2.724*	.000
		10	-3.735*	.000
		11	-12.078*	.000
		12	-18.129*	.000
	9	10	-1.011	.643
		11	-9.354*	.000
		12	-15.405*	.000
	10	11	-8.343*	.000
		12	-14.394*	.000
	11	12	-6.050*	.000

*. The mean difference is significant at the 0.05 level

A descriptive analysis was conducted to examine age-related differences in body circumferences among preadolescent boys aged 6 to 12 years (N = 1040) (Table 4). Mean and standard deviation values for chest, upper arm, forearm, thigh, calf, waist and hip circumferences are shown in Table 4. Results of the present study indicated a consistent increase in the mean values of all circumferential measures with increasing age. Chest circumference increased from 57.00 ± 0.08cm at age 6 year to 70.66 ± 1.26cm, at age 12 years, with an overall mean of 64.84 ± 4.57 cm. Similarly, waist circumference showed the largest absolute increase, from 51.60 ± 0.09cm at age 6 year to 65.54 ±1.54cm at age 12 year, with an overall mean of 59.50 ± 4.92cm. Hip circumference also increased from 52.90 ± 0.07cm to 62.53 ± 1.23 cm, with an overall mean of 58.90 ± 3.39 cm. Limb circumferences demonstrated smaller but steady increases. Upper arm circumference increased from 17.00 ± 0.09 cm to 20.08 ± 0.53cm, with an overall mean of 18.91±1.15cm and plateaued between ages 11years and 12 years. Forearm circumference increased from 14.40 ±0.07cm to 17.70 ±0.54cm, with an overall mean of 16.36 ±1.17 cm. Thigh circumference increased from 31.90 ±0.06 cm to 38.67 ±0.94 cm, with an overall mean of 35.96 ± 2.42 cm. Calf circumference increased from 24.80 ± 0.08cm to 28.20 ± 0.93cm, with an overall mean of 26.96 ± 1.40 cm, with a slight decrease observed at age 12 years. Overall, the results of the present study suggest that body circumferences increase progressively during preadolescence, with trunk circumferences, particularly waist and chest, exhibiting greater growth compared to limb circumferences. Variability, as indicated by standard deviation (SD), also tended to increase with age, suggesting greater heterogeneity in body size in older age groups.

Table 4 . Mean± SD of Body Circumferences of Preadolescent Boys

Variable(s)	Age (years)	N	Mean	Std. Deviation
Chest circumference (cm)	6	107	57.00	.08
	7	148	60.63	1.81
	8	104	61.35	1.30
	9	173	63.98	1.59
	10	153	66.35	1.41
	11	172	68.80	1.12
	12	183	70.66	1.26
	Total	1040	64.84	4.57
Upper arm circumference (cm)	1	107	17.00	.09
	2	148	17.73	.43
	3	104	18.26	.49
	4	173	18.80	.56
	5	153	19.22	.56
	6	172	20.08	.49
	7	183	20.08	.53
	Total	1040	18.91	1.15
Forearm circumference	1	107	14.40	.07
	2	148	15.34	.48

(cm)	3	104	15.48	.39
	4	173	16.17	.54
	5	153	16.78	.51
	6	172	17.40	.53
	7	183	17.70	.54
	Total	1040	16.36	1.17
Thigh circumference (cm)	1	107	31.90	.06
	2	148	33.71	1.16
	3	104	34.26	1.01
	4	173	35.73	1.16
	5	153	36.54	1.02
	6	172	38.27	.70
	7	183	38.67	.94
	Total	1040	35.96	2.42
Calf circumference (cm)	1	107	24.80	.08
	2	148	25.87	.71
	3	104	26.07	.81
	4	173	26.74	.98
	5	153	27.41	.89
	6	172	28.25	.73
	7	183	28.20	.93
	Total	1040	26.96	1.40
Waist circumference (cm)	1	107	51.60	.09
	2	148	54.89	2.06
	3	104	55.47	1.40
	4	173	58.31	1.87
	5	153	60.93	1.71
	6	172	64.34	.79
	7	183	65.54	1.54
	Total	1040	59.50	4.92
Hip circumference (cm)	1	107	52.90	.07
	2	148	55.99	1.28
	3	104	56.56	1.23
	4	173	58.03	1.60
	5	153	60.46	1.42
	6	171	62.18	.89
	7	183	62.53	1.23
	Total	1039	58.90	3.39

Age Effect: All circumferences increase significantly with age, reflecting normal growth and development during preadolescence. This is expected due to bone growth, muscle mass increase, and fat deposition.
Rate of Growth: Highest growth - waist > chest > hip > thigh and lowest growth - upper arm > forearm > calf.
This suggests central body regions grow faster than limb circumferences in this age group.
Variability: The standard deviation (SD) is smallest at age 6 years for all variables, indicating boys are more homogeneous in body size at younger ages. The standard deviation (SD) increases with age, especially for waist and chest, showing greater diversity in body composition as boys approach adolescence. The increasing standard deviation (SD) with age suggests growing heterogeneity in body size, muscle mass and fat distribution as boys progress toward adolescence.
A one-way analysis of variance (ANOVA) was conducted to examine whether body circumferences differed significantly across age groups among preadolescent boys aged 6 to 12 years (Table 5). The independent variable was age group with seven levels, and the dependent variables were chest, upper arm, forearm, thigh, calf, waist, and hip circumferences. Results of the ANOVA indicated statistically significant differences between age groups for all body circumference variables (Table 5). Chest circumference differed significantly across age groups, $F(6, 1033) = 1789.03$, $p < .001$. Similarly, significant age differences were found for upper arm circumference, $F(6, 1033) = 784.57$, $p < .001$; forearm circumference, $F(6, 1033) = 842.62$, $p < .001$; thigh circumference, $F(6, 1033) = 937.59$, $p < .001$; calf circumference, $F(6, 1033) = 345.03$, $p < .001$; waist circumference, $F(6, 1033) = 1620.10$, $p < .001$; and hip circumference, $F(6, 1033) = 1148.03$, $p < .001$ (see Table 5). The largest F value was observed for chest circumference, followed by waist circumference, indicating that these trunk measures showed the greatest variation across age groups. All p values were less than .001, suggesting that age had a highly significant effect on all circumferential measures in preadolescent boys. Post hoc tests are recommended to determine the specific age groups that differ from one another.

Table 5. Analysis of Variance (ANOVA) of Body Circumferences of Preadolescent Boys

Variable(s)		df	Mean Square	F	Sig.
Chest circumference (cm)	Between Groups	6	3306.64	1789.03	.000
	Within Groups	1033	1.84		
Upper arm circumference (cm)	Between Groups	6	190.70	784.57	.000
	Within Groups	1033	.24		
Forearm circumference (cm)	Between Groups	6	199.17	842.62	.000
	Within Groups	1033	.23		
Thigh circumference (cm)	Between Groups	6	857.74	937.59	.000
	Within Groups	1033	.91		
Calf circumference (cm)	Between Groups	6	227.59	345.03	.000
	Within Groups	1033	.66		
Waist circumference (cm)	Between Groups	6	3795.59	1620.10	.000
	Within Groups	1033	2.34		
Hip circumference (cm)	Between Groups	6	1738.75	1148.03	.000
	Within Groups	1033	1.51		

To determine which specific age groups differed in body circumferences, Scheffe post hoc tests were conducted following the significant ANOVA results. The dependent variables were chest, upper arm, forearm, thigh, calf, waist, and hip circumferences, and the independent variable was age group with seven levels from 6 to 12 years. Results (Table 6) indicated that for chest, thigh, and waist circumferences, all pairwise comparisons between age groups were statistically significant at $p < .05$, except for waist circumference between ages 7 and 8 years ($p = .196$). For example, chest circumference differed significantly between 6-year-olds and 12-year-olds, the mean difference -13.66 cm, $p < .001$, and between 11-year-olds and 12-year-olds, the mean difference -1.86 cm, $p < .001$. Similarly, waist circumference was significantly higher in 12-year-olds compared to 6-year-olds, the mean difference -13.94 cm, $p < .001$. For upper arm circumference, all pairwise comparisons were significant ($p < .001$) except between 11 and 12-year-olds, the mean difference 0.005 cm, $p = 1.000$, indicating a plateau in growth between these ages. For forearm circumference, all comparisons were significant ($p < .001$) except between 7 and 8-year-olds, the mean difference -0.14 cm, $p = .521$(Table 6). For calf circumference, all comparisons were significant ($p < .001$) except between 7 and 8-year-olds, the mean difference -0.20 cm, $p = .719$, and between 11 and 12-year-olds, the mean difference 0.05 cm, $p = .999$. For hip circumference, all comparisons were significant ($p < .05$) except between 11 and 12-year-olds, the mean difference -0.35 cm, $p = .318$. Overall, post hoc analyses revealed that most body circumferences increased significantly with each successive year of age. However, upper arm, calf, and hip circumferences showed no significant difference between the oldest two age groups, suggesting a leveling off of growth in late preadolescence (Table 6).

Table 6. Posthoc (Scheffe) Multiple Comparisons of Body Circumferences of Preadolescent Boys

Dependent Variable	(I) age	(J) age	Mean Difference (I-J)	Sig.
Chest circumference (cm)	1	2	-3.6351*	.000
		3	-4.3519*	.000
		4	-6.9838*	.000
		5	-9.3529*	.000
		6	-11.8023*	.000
		7	-13.6623*	.000
	2	3	-.7168*	.010
		4	-3.3487*	.000
		5	-5.7178*	.000
		6	-8.1672*	.000
		7	-10.0272*	.000
	3	4	-2.6319*	.000
		5	-5.0010*	.000
		6	-7.4504*	.000
		7	-9.3104*	.000
	4	5	-2.3691*	.000
		6	-4.8185*	.000
		7	-6.6785*	.000

	5	6	-2.4494*	.000
		7	-4.3094*	.000
	6	7	-1.8600*	.000
Upper arm circumference (cm)	1	2	-.7358*	.000
		3	-1.2625*	.000
		4	-1.8029*	.000
		5	-2.2255*	.000
		6	-3.0860*	.000
		7	-3.0814*	.000
	2	3	-.5267*	.000
		4	-1.0671*	.000
		5	-1.4897*	.000
		6	-2.3502*	.000
		7	-2.3456*	.000
	3	4	-.5404*	.000
		5	-.9630*	.000
		6	-1.8235*	.000
		7	-1.8189*	.000
	4	5	-.4226*	.000
		6	-1.2832*	.000
		7	-1.2785*	.000
	5	6	-.8606*	.000
		7	-.8559*	.000
	6	7	.0046	1.000
Forearm circumference (cm)	1	2	-.9439*	.000
		3	-1.0856*	.000
		4	-1.7763*	.000
		5	-2.3810*	.000
		6	-3.0017*	.000
		7	-3.3071*	.000
	2	3	-.1417	.521
		4	-.8324*	.000
		5	-1.4371*	.000
		6	-2.0578*	.000
		7	-2.3632*	.000
	3	4	-.6907*	.000
		5	-1.2955*	.000
		6	-1.9162*	.000
		7	-2.2215*	.000
	4	5	-.6047*	.000
		6	-1.2254*	.000
		7	-1.5308*	.000
	5	6	-.6207*	.000
		7	-.9261*	.000
	6	7	-.3054*	.000
Thigh circumference (cm)	1	2	-1.8135*	.000
		3	-2.3635*	.000
		4	-3.8376*	.000
		5	-4.6490*	.000
		6	-6.3756*	.000
		7	-6.7787*	.000

	2	3	-.5499*	.003
		4	-2.0241*	.000
		5	-2.8355*	.000
		6	-4.5621*	.000
		7	-4.9652*	.000
	3	4	-1.4741*	.000
		5	-2.2856*	.000
		6	-4.0121*	.000
		7	-4.4152*	.000
	4	5	-.8114*	.000
		6	-2.5380*	.000
		7	-2.9411*	.000
	5	6	-1.7266*	.000
		7	-2.1297*	.000
	6	7	-.4031*	.016
Calf circumference (cm)	1	2	-1.0784*	.000
		3	-1.2779*	.000
		4	-1.9474*	.000
		5	-2.6176*	.000
		6	-3.4552*	.000
		7	-3.4055*	.000
	2	3	-.1995	.719
		4	-.8690*	.000
		5	-1.5393*	.000
		6	-2.3769*	.000
		7	-2.3271*	.000
	3	4	-.6695*	.000
		5	-1.3398*	.000
		6	-2.1773*	.000
		7	-2.1276*	.000
	4	5	-.6702*	.000
		6	-1.5078*	.000
		7	-1.4581*	.000
	5	6	-.8376*	.000
		7	-.7878*	.000
	6	7	.0498	.999
Waist circumference (cm)	1	2	-3.2973*	.000
		3	-3.8731*	.000
		4	-6.7179*	.000
		5	-9.3333*	.000
		6	-12.7419*	.000
		7	-13.9443*	.000
	2	3	-.5758	.196
		4	-3.4206*	.000
		5	-6.0360*	.000
		6	-9.4446*	.000
		7	-10.6470*	.000
	3	4	-2.8448*	.000
		5	-5.4603*	.000
		6	-8.8688*	.000
		7	-10.0712*	.000

	4	5	-2.6154*	.000
		6	-6.0239*	.000
		7	-7.2263*	.000
	5	6	-3.4085*	.000
		7	-4.6109*	.000
	6	7	-1.2024*	.000
Hip circumference (cm)	1	2	-3.0912*	.000
		3	-3.6692*	.000
		4	-5.1324*	.000
		5	-7.5627*	.000
		6	-9.2848*	.000
		7	-9.6322*	.000
	2	3	-.5780*	.037
		4	-2.0412*	.000
		5	-4.4715*	.000
		6	-6.1936*	.000
		7	-6.5410*	.000
	3	4	-1.4631*	.000
		5	-3.8935*	.000
		6	-5.6156*	.000
		7	-5.9630*	.000
	4	5	-2.4304*	.000
		6	-4.1524*	.000
		7	-4.4999*	.000
	5	6	-1.7221*	.000
		7	-2.0695*	.000
	6	7	-.3474	.318

*. The mean difference is significant at the 0.05 level.

Discussion

The present study aimed to evaluate age-related changes in body height, body weight and body circumferences among preadolescent boys aged 6 to 12 years.

Height and Weight Growth Dynamics

Mean body height increased significantly each year from 6 to 11 years but plateaued between 11 and 12 years. This cessation of significant height gain at 11–12 years suggests that, for this cohort, the pre-adolescent growth spurt in stature may peak before age 12. In contrast, body weight continued to increase significantly through 12 years, except for a brief stabilization at 9–10 years. The continued weight gain despite a height plateau implies disproportionate increases in body mass, likely due to gains in muscle mass, skeletal mass, or adipose tissue as boys approach adolescence. The largest annual increments in both height and weight occurred between 10–11 years, indicating this interval may represent peak growth velocity for overall body size in the present sample.

Body Circumferences

The results of the present study demonstrate a significant progressive increase in all measured circumferences with advancing age. Both trunk and limb circumferences showed statistically significant differences across age groups, indicating that growth during preadolescence is not uniform across body segments. The highest F values were observed for chest circumference $F(6, 1033) = 1789.03$ and waist circumference $F(6, 1033) = 1620.10$, suggesting that trunk dimensions undergo greater variation with age compared to limb circumferences. This finding is consistent with previous reports that trunk growth is more pronounced during preadolescence due to increased skeletal growth and visceral organ development. Similarly, Gupta et al. (2009) reported significant

age-related increments in chest and waist circumferences among Indian school children, supporting the present findings (de Onis et al., 2007; WHO 2006).

Scheffe post hoc analysis revealed that most pairwise comparisons between consecutive age groups were significant for all variables. However, upper arm, calf, and hip circumferences showed no significant difference between 11 and 12-year-olds. This plateau in late preadolescence may reflect the transition phase prior to the adolescent growth spurt, where limb growth temporarily slows before pubertal acceleration. Malina et al. (2004) also noted that differential timing of growth in various body segments contributes to changes in body proportions during late childhood (Rogol et al., 2002 ; Tanner 1962).

The significant differences in forearm and calf circumferences between most age groups, except 7-8 years, suggest that distal limb segments may have relatively slower growth rates during mid-preadolescence. This pattern aligns with Tanner's observation that growth in length precedes growth in girth during childhood, and that limb girth increases become more evident closer to puberty (Eveleth and Tanner 1990).

Waist and hip circumferences, which are important indicators of central fat distribution and metabolic risk, also increased significantly with age. The consistent increase in waist circumference from 51.60 cm at age 6 to 65.54 cm at age 12 underscores the need for age-specific reference values for screening abdominal obesity in children. Singh and Sharma reported similar trends in Punjabi school children, emphasizing the role of regional anthropometric data in health monitoring (Singh and Sharma 2011 ; McCarthy et al., 2001).

A major strength of this study is the use of a relatively large sample with standardized measurement protocols and robust statistical analysis including ANOVA and Scheffe post hoc tests. However, the cross-sectional design limits the ability to infer individual growth trajectories. Longitudinal studies are needed to confirm these age-related patterns. In conclusion, the findings provide normative reference data for body circumferences in preadolescent boys and confirm that age has a highly significant effect on all circumferential measures. These data can be useful for clinicians, nutritionists, and physical anthropologists for growth assessment and for developing population-specific growth charts.

Conclusion

The results of the present study reveal that body height increased significantly until 11 years and then plateaued, whereas body weight continued to rise through 12 years, indicating differential changes in body composition during late pre-adolescence. The body circumferences also increase significantly with age during preadolescence. Trunk circumferences, particularly chest and waist, showed the greatest absolute and statistical differences across age groups, while limb circumferences demonstrated relatively smaller but consistent increments. Scheffe post hoc analysis indicated that most age groups differed significantly from each other. However, a plateau was observed between 11- and 12-year-olds for upper arm, calf, and hip circumferences, suggesting a temporary stabilization of growth in certain body segments prior to the adolescent growth spurt. These results confirm that age is a major determinant of body circumference variation in boys and highlight the importance of age-specific reference values for growth monitoring.

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